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E. J. Stone, M.A., F.R.S., President, in the Chair.

Prof. S. P. Langley, Allegheny Observatory, Pennsylvania;
Prof. J. A. C. Oudemans, the Observatory, Utrecht;
Prof. P. Tacchini, Collegio Romano, Rome; and
Prof. E. Weiss, the Observatory, Vienna;
were balloted for and duly elected Associates of the Society.
James S. Cooke, Springfield, Gomersal, near Leeds;
Alexander von Gothard, Herény Observatory, Hungary;
Eugen von Gothard, Herény Observatory, Hungary;
Capt. Richard Ladd, F.M.S., 106, Sandgate Road, Folkestone; and
Robert Rawson, Assoc. I.N.A., Havant, Hants;

were balloted for and duly elected Fellows of the Society.

Note on the Greenwich Mean Tabular Errors of the R. A. of the Sun. By E. Dunkin, F.R.S.

In the table of mean tabular errors of the Sun in longitude given by Mr. Stone in his paper on "An Explanation of the Principal Cause of the larger Errors at present existing between the Positions of the Moon deduced from Hansen's Tables and from Observation," &c. (*Monthly Notices*, vol. xliii. p. 337), the changes appear so remarkable, especially in the almost sudden increase in the errors after the year 1872, that it is highly important that any explanation of this apparent increase in the tabular errors of longitude, or of the R.A. of the Sun, should be at once placed on

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record. Mr. Stone considers that the general increase is clearly progressive, amounting roughly to 0″·052 per annum, and he believes that it is the effect of the change of unit adopted by Le Verrier in his Solar Tables.

Without wishing to enter into a controversy on the subject of Mr. Stone's paper, I think I may venture to offer another explanation, which will also clearly show that this apparent positive increase in the observed tabular errors of the R.A. of the Sun may be accounted for as being the effect of "personality" in the observers employed in making the observations. It so happened that between the years 1872 and 1875 several important changes took place in the regular observing staff at Greenwich. Observers who were in the habit of systematically giving large negative errors were succeeded by others who, on the contrary, give large positive errors. The existence of a peculiar personality in observing the limbs of the Sun and Moon has been known to me for many years, long before the preparation of my two papers on personality in observing transits of the first and second limbs. In these papers I have conclusively shown that even experienced observers differ widely in their methods of observing the limbs of the Sun and Moon (*Monthly Notices*, vols. xxix. and xxxv.)

The numbers given in the following table for each of the principal observers show how much the mean tabular errors of the R.A. of the Sun have been affected by the introduction of new observers. These numbers require no explanation further than to state that all the tabular errors in R.A. of the Sun have been extracted, without exception, from the "Astronomical Results" contained in the *Greenwich Observations* for the years from 1864 to 1881. These errors have been classified for each year into observers' groups. All the errors deduced from the observations of the computers and other occasional observers are included in one miscellaneous group, but any evidence obtained from this group is of lesser importance, as the observers are never in any two years the same, and many of them have not attained the trained experience of the assistants. In the following table the yearly mean errors derived from the observations of all the occasional observers are inserted, but no attempt has been made to ascertain the amount of their separate personalities, though the errors themselves show that personality exists in some instances in a tolerably large degree.

In the following tables the initials of the observers D, E, L, C, JC, AD, T and TL, are respectively those of Mr. Dunkin, Mr. Ellis, Mr. Lynn, Mr. Criswick, Mr. Carpenter, Mr. Downing, Mr. Thackeray, and Mr. Lewis. The mean tabular errors are expressed in seconds of arc.

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Mean Tabular Errors of R.A. of the Sun.

Year.	D Tab. Error of R.A.	D No. of Obs.	E Tab. Error of R.A.	E No. of Obs.	C Tab. Error of R.A.	C No. of Obs.	JC Tab. Error of R.A.	JC No. of Obs.	Miscellaneous. Tab. Error of R.A.	Miscellaneous. No. of Obs.
1864	−0″·07	17	−0″·25	23	+0″·19	28	−0″·97	24	+1″·03	30
1865	−0·09	21	+0·18	24	+0·55	28	−0·03	19	+0·38	29
1866	−0·34	19	−0·87	20	−0·10	16	−0·67	21	+0·67	33
1867	−0·36	14	−1·48	16	+0·84	17	−0·79	18	+0·26	27
1868	+0·13	21	−0·88	21	+0·21	25	−0·19	19	+0·84	45
1869	+0·55	14	−0·58	18	+0·51	18	−0·17	18	+0·82	30
	L									
1870	+0·21	18	−0·46	20	+0·45	23	−0·56	28	+0·75	37
1871	−0·03	28	−0·17	15	+0·18	16	−1·17	15	+1·42	39
1872	+0·79	25	−0·91	23	−0·07	19	−1·29	16	+0·39	37
							AD			
1873	+0·91	21	−0·60	20	+0·33	20	+0·61	29	+0·90	34
1874	+1·09	22	−0·34	12	+0·52	20	+1·72	20	+0·62	32
			T							
1875	+1·08	17	+0·15	15	+0·45	15	+0·84	15	+0·97	49
1876	+1·33	12	+0·20	22	+0·36	16	+0·64	24	+1·08	38
1877	+0·24	9	+0·08	13	+0·79	13	+0·42	16	+1·06	34
1878			+0·78	12	+0·33	14	+0·21	14	+1·05	45
1879			+0·66	13	+0·08	15	+0·31	15	+1·29	34
1880			+0·69	20	+0·19	17	−0·09	27	+1·53	51
	TL									
1881	+1·14	27	+0·52	19	+0·22	17	+0·48	24	+0·96	33

From 1878 to the end of 1880, owing to the illness and subsequent resignation of Mr. Lynn, three assistants only made regular observations with the Transit Circle, which accounts for the rather larger number of observations made by the computers in those years.

Referring all the numbers in the preceding table to Mr. Criswick as the standard, and dividing the group of each observer into smaller groups determined either by the change of observers or when there is shown a decided difference in the value of the errors, we obtain a series of comparisons between Mr. Criswick and each observer, and indirectly between any two observers; and thus corrections can be deduced to be applied to the mean of all the errors for the years between which a change of observers took place.

Period.	Observers.		Difference.	
1864–1869	D−C	=	−0″·40	
1864–1869	E−C	=	−1·01	Mean = −0″·90
1870–1874	E−C	=	−0·78	
1864–1869	JC−C	=	−0·84	Mean = −1″·02
1870–1872	JC−C	=	−1·19	

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Period.	Observers.		Difference.
1870 – 1871	L – C	=	– 0·23
1872 – 1877	L – C	=	+ 0·51
1873 – 1874	AD – C	=	+ 0·74
1875 – 1881	AD – C	=	– 0·01
1875 – 1881	T – C	=	+ 0·09
1881	TL – C	=	+ 0·92

Assuming on an average that the number of observations of each observer is approximately about one-sixth part of the whole number for each year, corrections have been determined from these differences, and applied to form the corrected values in the third and sixth columns in the next table. It will be observed that though the discordances in the third column of mean errors are greatly diminished between the periods before and after 1873, the errors are not entirely cleared of the personality, as it still remains in full force in the miscellaneous group, which has in some years a very considerable weight in determining the yearly combined mean of the tabular errors. The following table contains the mean of the errors determined by all the observers for each year, with the resulting values as corrected for the personality due to the changes in the assistants, and also the means of the tabular errors determined from observations made by the assistants only, with the corresponding resulting values corrected for personality.

Year.	Uncorrected Mean Tab. Error of R.A. of Sun from all the Observations.	Mean Tab. Error of R.A. of Sun corrected for Personality due to change of Assistants.	No. of Obs.	Uncorrected Mean Tab. Error of Sun from Observations by the Assistants only.	Mean Tab. Error of Sun from Observations by the Assistants only, corrected for Personality due to change of Assistants.	No. of Obs.
	″	″		″	″	
1864	+ 0·05	+ 0·05	122	– 0·27	– 0·27	92
1865	+ 0·23	+ 0·23	121	+ 0·20	+ 0·20	92
1866	– 0·17	– 0·17	109	– 0·53	– 0·53	76
1867	– 0·20	– 0·20	92	– 0·44	– 0·44	65
1868	+ 0·24	+ 0·24	131	– 0·17	– 0·17	86
1869	+ 0·15	+ 0·15	98	+ 0·07	+ 0·07	68
1870	+ 0·13	+ 0·09	126	– 0·12	– 0·16	89
1871	+ 0·32	+ 0·28	112	– 0·22	– 0·26	74
1872	– 0·12	– 0·30	120	– 0·27	– 0·54	83
1873	+ 0·51	+ 0·04	124	+ 0·36	– 0·35	90
1874	+ 0·80	+ 0·33	106	+ 0·57	– 0·14	74
1875	+ 0·79	+ 0·30	111	+ 0·65	– 0·11	62
1876	+ 0·75	+ 0·26	112	+ 0·56	– 0·20	74
1877	+ 0·66	+ 0·17	85	+ 0·40	– 0·36	51
1878	+ 0·75	+ 0·42	85	+ 0·42	– 0·24	40
1879	+ 0·75	+ 0·42	77	+ 0·34	– 0·32	43
1880	+ 0·81	+ 0·48	115	+ 0·23	– 0·43	64
1881	+ 0·73	+ 0·18	120	+ 0·64	– 0·18	87

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The effect of the change of assistants on the tabular error of the R.A. of the Sun as determined from observations made with the Transit Circle is well marked in the preceding table, especially in the fifth and sixth columns, in which the errors determined from the observations of the computers have been omitted. It may be remarked that in 1870 Mr. Dunkin was succeeded by Mr. Lynn; in 1873 Mr. Carpenter by Mr. Downing; in 1875 Mr. Ellis by Mr. Thackeray; and in 1881 Mr. Lynn by Mr. Lewis.

Some of the outstanding discordances in the third column can be explained by an examination of the separate errors as given by each observer. In 1866 and 1867 two computers had undoubtedly a considerable negative personality, while as a rule it has been noticed that the young observers have a tendency to observe either the first or second limb too early, and consequently the tabular errors in R.A. for the centre of the Sun are too great. In these years the negative tabular errors determined from the observation of some of the assistants are also larger than in other years. From 1878 to 1880, owing to Mr. Lynn ceasing to observe, it became necessary to employ computers more than usual to supply his place; and the effect of their exceptionally large errors, due to personality principally, is shown in the corrected mean errors for those three years, in which a large personality for the miscellaneous group remains. In 1872 there was a great preponderance of negative errors, the cause of which cannot at present be explained.

The only assistant who has observed continuously from 1864 to 1881 is Mr. Criswick, and as it is found from the comparison of his observations with those of the other observers that no sensible change has taken place in his method of observing the Sun during the whole period, the errors deduced from his observations ought to give some reliable evidence of a progressive increase in the tabular error of R.A., if such a change be really in progress. Dividing his observations into three groups, and also the corresponding corrected errors determined by the assistants, we have:

Period.	Mean Tab. Error of R.A.	No. of Obs.	Mean corrected Tab. Error of R.A. by Assistants.	No. of Obs.
1864–1869	+0″·36	132	−0″·19	479
1870–1875	+0·32	113	−0·26	472
1876–1881	+0·31	92	−0·29	359

These numbers are closer than might have been expected, and they indicate a diminishing rather than an increasing error.

I have already remarked that similar personalities in observing the limbs of the Moon have been shown to exist, and on referring to a comparison of the observations of different observers given in my paper (*Monthly Notices*, vol. xxxv. p. 94), it may be observed that the relative differences are about the same amount as those exhibited above for the Sun.

Royal Observatory, Greenwich,
1883, *November* 8.

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Note on the Mass of Saturn. By Prof. Asaph Hall.

(*Communicated by Rear-Admiral R. W. Shufeldt, Supt. of Naval Observatory.*)

At the beginning of my observations with the 26-inch Equatorial at Washington in 1875, the apparent difference of declination of *Iapetus*, the outer satellite of *Saturn*, and the planet was very small. It occurred to me that it would be well to observe the difference of Right Ascension and Declination of the planet and satellite, since the mean distance of the satellite would be determined chiefly from the difference of Right Ascension, and so would not depend essentially on the assumed value of a revolution of the micrometer screw. *Iapetus* was observed therefore in this manner in 1875, 1876, and 1877. The differences of Right Ascension were observed as carefully as possible on a chronograph. In 1875 each difference of Right Ascension depends on about twenty-five transits, and in the other years on about twenty transits. The average probable error of a single difference of Right Ascension is ±0ˢ·044. Both limbs of *Saturn* were observed; and in every year the satellite was observed in both positions, preceding and following the planet. Each difference of Declination depends on five bisections of the planet and satellite.

The observed differences of Right Ascension and Declination correspond to what Bessel denotes as x and y in his work on the orbit of *Titan* (*Astronomische Nachrichten*, Band 9); and the equations of condition are formed very conveniently by means of Bessel's formulæ. The equations for each year have been treated separately, since the periodical perturbations of this satellite produced by the Sun are quite large. The solution of the equations of condition by the method of least squares gives the following values of the mean distance of *Iapetus* from *Saturn* at the distance 9·53885.

1875	$a = 515''\cdot594 \pm 0''\cdot056$	57 observations.
1876	$a = 515\cdot454 \pm 0\cdot058$	40 „
1877	$a = 515\cdot517 \pm 0\cdot053$	31 „
Mean	$a = 515\cdot522$	128 „

The following table shows the number of equations of condition for each year; the sum of the squares of the independent terms before solution, the sum of the squares of the residuals after solution, first by elimination, and again by substitution; the maximum residual left in the equations after substitution, and the probable error of a single equation.

Year.	No of Equat.	$[nn]$	$[nn.6]$	$\Sigma.\nu^2$	Max. Residual	r_1
1875	109	172″·274	27″·136	27″·095	1″·49	± 0″·346
1876	78	107·453	15·806	15·803	1·31	± 0·316
1877	61	110·935	8·336	8·324	1·26	± 0·263